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PHILOSOPHICAL TRANSACTIONS.

Wednesday, July 18. 1666.

The Contents.

A new Experiment, shewing, How a considerable degree of Cold may be suddenly produced without the help of Snow, Ice, Haile, Wind, or Niter, and that at any time of the year. An Account of two Books, lately printed in London; whereof the one is intituled, EUCLIDIS ELEMENTA GEOMETRICA, novo ordine ac Methodo demonstrata; the Author Anonymus. The other, THE ENGLISH VINEYARD VIN- DICATED, by JOHN ROSE.

A new Frigorifick Experiment shewing, how a considerable degree of Cold may be suddenly produced without the help of Snow, Ice, Haile, Wind, or Niter, and that at any time of the year.



His subject will it self, 'tis presumed, without any other *Preamble*, speak the Cause, why this present Paper is publish't at this (unusual) time of the Month: though, by the by, it may not be amiss to add on this occasion, that the Publisher of these *Traacts* never meant so to confine himself to a *Set* time, as not to retain the Liberty of taking any other, when there is occasion. And there being one given him, before another Month is come in, he does without any scruple or delay comply therewith, presenting the Curious with an Experiment which he thinks is both seasonable, and will not be unwellcome to them; furnish't out of the Ample Magazin of that Philosophical Benefactor, the Noble Mr. Boyle; Concerning which, thus much is further thought requisite to intimate on this occasion, that it, and some others of the same Gentlemen, that have been, and may be, mentioned in the *Transactions*, belong to certain Treatises, the Author hath lying by him; but that yet he deny's not

to communicate them to his Friends, and to allow them to dispose thereof, upon a hope, that equitable Readers will be ready to excuse, if hereafter they should appear also in the Treatises they belong to, since he consents to this Anticipation, but to comply with those, that think the imparting of real and practical Experiments, may do the Publick some Service, by exciting and assisting mens Curiosity in the interim.

As for the Experiment, you saw the other day at my Lodgings, though it belongs to some Papers about *Cold*, that (you know) could not be Publish'd, when the rest of the *History* came forth, and therefore was reserved for the next *Edition* of that Book; yet the Weather having been of late very hot, and threatening to continue so, I presume, that to give you here in compliance with your Curiosity an Account of the Main and Practicall part of the Experiment, may enable you to gratify not onely the Curious among your Friends, but those of the Delicate, that are content to purchase a Coolness of Drinks at a somewhat chargeable rate.

You may remember, that the Spring before the last, I shew'd you a particular Account of a way, wherein by a certain substance obtain'd from *Sal Armoniack*, I could presently produce a considerable degree of *Cold*, and that with odd Circumstances, without the help of *Snow*, *Ice*, *Niter* &c. But that Experiment being difficult and costly enough, and design'd to afford men *Information*, not *Accommodations*, I afterwards tryed, what some more cheap and facile mixtures of likely Bodies with *Sal Armoniack* would do towards the Production of *Cold*, and afterwards I began to consider, whether to that purpose alone (for my first experiment was design'd to exhibite other *Phænomena* too) those mixtures might not without inconvenience be omitted: and I was much confirm'd in my conjecture, by an accident, which was casually related to me by a very Ingenious Physician of my acquaintance, but not to be repeated to you in few words, though he complain'd, he knew not what to make of it.

Among the several ways, by which I have made infrigidating Mixtures with *Sal Armoniack*, the most simple and facile is this: Take one pound of powder'd *Sal Armoniack*, and about three Piats (or pounds) of Water, put the Salt into the Liquor, *either* altogether, if your design be to produce an intense, though
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but a short coldness; or at two, three, or four several times, if you desire, that the produced coldness should rather last somewhat longer than be so great. Stirre the powder in the Liquor with a stick or whalebone (or some other thing, that will not be injur'd by the fretting Brine, that will be made) to hasten the dissolution of the Salt; upon the quickness of which depends very much the intensity of the Cold, that will ensue upon this Experiment. For the clearing up whereof, I shall annex the following particulars.

1. That a considerable degree of Cold is really produced by this operation, is very evident: *First*, to the touch; *Secondly*, by this, that if you make the Experiment (as for this reason I sometimes chuse to do) in a Glass-Body or a Tankard, you may observe, that, whilst the Solution of the Salt is making, the outside of the Metalline Vessel will, as high as the mixture reaches within, be bedew'd (if I may so speak) with a multitude of little Drops of Water, as I have * elsewhere shewn that it happens, when mixtures of Snow and Salt, being put into Glasses or other Vessels, the aqueous vapors, that swim to and fro in the Air, and chance to glide along the sides of the Vessels, are by the coldness thereof condens'd into Water. And in our Armoniack Solution you may observe, that if you wipe off the Dew from any particular part of the outside of the Vessel, whilst the solution does yet vigorously goe on, it will quickly collect fresh Dew, which may be sometimes copious enough to run down the sides of the Vessel. But *Thirdly*, the best and surest way of finding out the Coldness of our Mixture is that, which I shew'd you by plunging into it a good seal'd Weatherglass furnish't with tinted Spirit of Wine. For, the Ball of this being put into our frigorifick mixture, the Crimson Liquor will nimbly enough descend much lower, than when it was kept either in the open Air, in common Water, of the same temper with that, wherein the *Sal Armoniack* was put to dissolve. And if you remove the Glass out of our Mixture into common water, the tinted Spirit will, (as you may remember, it did) hastily enough reascend for a pretty while, according to the greater or lesser time, that it continued in the *Armoniack* Solution. And this has succeeded with me, when instead of removing the Mixture into Common Water, I removed it into water newly impregnated with *Salt-peter*.

* In the History
of Cold.

2. The *Duration* of the Cold, produc'd by this Experiment, depends upon several Circumstances; as *First*, upon the Season of the year, and present temperature of the Air; For, in Summer and Hot weather the Cold will sooner decay and expire. *Secondly*, upon the Quantity of the Salt and Water: For, if both these be great, the effect will be as well more lasting, as more considerable. *Thirdly*, for ought I yet know, we may here add the Goodness & Fitness of the particular parcel of Salt, that is imploy'd: for, though it be hard to discern beforehand, which will be the more, and which the less proper; yet some trials have tempted me to suspect, that there may be a considerable disparity, as to their fitness to produce Cold, betwixt parcels of Salt, that are without scruple look't upon as Sal Armoniack: Of which difference it were not perhaps very difficult to assign probable reasons from the Nature of the Ingredients of this compound Concrete, and the waies of preparing it. But the Duration of the Cold may be conceived to depend also, *Fourthly*, upon the Way of putting in the Salt into the Water. For, if you cast it in all at once, the Water will sooner acquire an intense degree of Coldness, but it will also the sooner return to its former temper; Whereas, if you desire but an inferiour degree of that Quality, but that may last longer (which will usually be the most convenient for the Cooling of Drinks,) then you may put in the Salt by little and little. For, keeping a long Weather-glass for a good while in our impregnated Mixture, I often purposely try'd, that, when the tinted liquor subsided but slowly, or was at a stand, by putting in, from time to time, 2. or 3. spoonfuls of fresh Salt, and stirring the Water to quicken the Dissolution, the Spirit of Wine would begin again to descend, if it were at a stand or rising, or subside much more swiftly than it did before. And if you would lengthen the Experiment, it may not be amiss, that part of the Sal Armoniack be but grossly beaten, that it may be the longer in dissolving, and consequently in Cooling the Water. Whilst there are dewy drops produced on the outside of the Vessel, 'tis a sign, that the Cold within continues pretty strong; for, when it ceases, these drops especially in warm weather, will by degrees vanish. But a surer way of measuring the duration of the Cold, is, by removing from time to time the Seal'd Weather-glass out of the Saline Mixture into the same common Water, with part of which it was made. And though it be not easie to determin any thing particularly about this matter, yet it may somewhat assist you in your Estimates, to be inform'd, That I have in the Spring by a good Weather-glass found a sensible adventitious Cold, made by a pound of Sal Armeniack at the utmost, to last about 2. or 3. hours:

3. To cool Drinks with this Mixture, you may put them in thin Glasses, the thinner the better; which (their orifices being stopp'd, and still kept above the Mixture) may be mov'd to and fro in it, and then be immediately pour'd out to be drunk: Though, when the Glass, I imployed, was conveniently shap'd, as, like a Sugar-loaf, or with a long Neck, I found it not amiss to drink it out of that, without pouring it into any other; which can scarce be done without lessning the Coolness. The refrigeration, if the Glass-vial be convenient, is quickly perform'd: And if one have a mind to cool his hands, he may readily do it by applying them to the outside of the Vessel, that contains the refrigerating Mixture, by whose help, pieces of Chrystal, or Bullets for the cooling of the

the Mouths or Hands of those patients, to whom it may be allow'd, may be potently cool'd, and other such refreshments may be easily procur'd.

4. How far Sal Armoniack, mingl'd with Sand or Earth, and not dissolv'd, but only moistn'd with a little Water sprinkl'd on it, will keep Bottles of Wine or other liquors more coole, than the Earth or that Sand alone will do, I have not yet had opportunity by sufficient trials fully to satisfy my self, and therefore resign that Enquiry to the Curious.

5. For the cooling of Air, and Liquors, to adjust Weather-glasses (to be able to do which, at all times of the year, was one of the chief aimes, that made me bethink my self of this Experiment,) or to give a small quantity of Beer &c. a moderate degree of coolness, it will not be requisite, to employ neer so much as a whole pound of Sal Armoniack at a time. For, you may easily observe by a seal'd Weather-glass, that a very few ounces, well powder'd and nimbly dissolv'd in about 4. times the weight of Water, will serve well enough for many purposes.

6. And that you may the less scruple at this, I shall tell you, that even before and after Midsummer, I have found the Cold producible by our Experiment to be considerable and useful for refrigerating of Drinks, &c. but if the Sal Armoniack be of the fittest sort (for I intimated above, that I suspected, 'tis not equally good) and if the season of the year do make no disadvantageous difference, the degree of Cold, that may be produced by no more than one pound (if not by less) of Sal Armoniack, may, within its own Sphere of Activity, be much more vehement, than I presume, you yet imagine, and may afford us excellent Standards to adjust seal'd Weather-glasses by; and for several other purposes. For I remember that in the Spring, about the end of *March*, or beginning of *April*, I was able with one pound of Sal Armoniack, and a requisite proportion of Water, to produce a degree of Cold much greater, than was necessary the preceding Winter, to make it frosty Weather abroad; nay I was able to produce real Ice in a space of time, almost incredibly short. To confirm which particulars, because they will probably seem strange to you, I will here annex the Transcript of an entry, that I find in a Note book of the *Phænomena* and success of one of those Experiments; as I then try'd it; though I should be ashamed to expose to your perusal a thing so rudely pen'd; if I did not hope, you would consider, that 'twas hastily written only for my own Remembrance. And that you may not stop at any thing in the immediately annexed Note, or the two, that follow, it will be requisite to premise this Account of the seal'd Thermoscope; (which was a good one) wherewith these Observations were made; That the length of the Cylindrical pipe was 16. Inches; the Ball, about the bigness of a somewhat large Walnut, and the Cavity of the Pipe by guess about an eighth or ninth part of an inch Diameter.

The First Experiment is thus registred! *March* the 27th, in the Seal'd Weather glass, when first put into the Water, the tincted Spirit rested at $8\frac{1}{2}$ inches: being suffered to stay there a good while, and now and then stirr'd to and fro in the Water; it descended at length a little beneath $7\frac{1}{2}$ inches; then the *Sal Armoniack* being put in, within about a quarter of an hour or a little more it descended to $2\frac{1}{8}$ inches, but before that time, in half a quar-

ter of an hour it began manifestly to freeze the vapours and drops of water on the outside of the Glafs. And when the frigorifick power was arriv'd at the height, I several times found, that water, thinly plac'd on the outside, whilst the mixture within was nimblely stirr'd up and down, would freeze in a quarter of a minute (by a Minute-watch.) At about $\frac{1}{4}$ of an hour after the infrigiding Body was put in, the Thermoscope, that had been taken out a while before, and yet was risen but to the lowest freezing mark, being again put in the liquor, fell an inch beneath the mark. At about $2\frac{1}{2}$ houres from the first Solution of the Salt I found the tincted liquor to be in the midst between the freezing marks, whereof the one was at $5\frac{1}{2}$ inches (at which height when the Tincture rested, it would usually be, some, though but a small, Frost abroad,) and the other at $4\frac{1}{4}$ inches; which was the height, to which strong and durable Frosts had reduced the liquor in the Winter. At 3. hours after the beginning of the Operation, I found not the Crimson-liquor higher than the upper Freezing mark newly mention'd; after which, it continued to rise very slowly for about an hour longer, beyond which time I had not occasion to observe it.

Thus far the *Note-book*; wherein there is mention made of a Circumstance of some former Experiments of the like kind, which I remember was very conspicuous in this newly recited. For, the frigorifick mixture having been made in a Glafs-body (as they call it) with a large and flattish bottom, a quantity of water, which I (purposely) spilt upon the Table, was by the operation of the mixture within the Glafs, made to freeze, and that strongly enough, the bottom of the Cucurbite to the Table, that stagnant liquor being turn'd into solid Ice, that continued a considerable while unthaw'd away, and was in some places about the thickness of a half Crown piece.

Another Observation, made the same Spring, but less solemn, as meant chiefly to shew the Duration of Cold in a high degree, is recorded in these terms: The first time, the Seal'd Weather-glass was put in, before it touch'd the common water, it stood at $8\frac{1}{8}$, having been left there a considerable while, and once or twice agitated the water, the tincted liquor sunk but to $7\frac{1}{8}$, or at furthest, $7\frac{5}{8}$; then the frigorifick liquor being put into the water with circumstances disadvantageous enough, in (about) half a quarter of an hour the tincted liquor fell beneath $3\frac{1}{4}$; and the Thermoscope, being taken out, and then put in again, an hour after the water had been first infrigided, subsided beneath 5 inches, and consequently within $\frac{1}{2}$ of an inch of the mark of the strongly freezing weather.

7. Whereas the grand thing, that is like to keep this Experiment from being as generally *Useful*, as perhaps it will prove *Luciferous*, is the Dearness of Sal Armoniack; two things may be offered to lessen this Inconvenience. For *first*, Sal Armoniack might be made much cheaper, if instead of fetching it beyond-sea, our Country-men made it here at home; (which it may easily be, and I am ready to give you the Receipt, which is no great Secret.) But *next*, I considered, that probably the infrigiding vertue of our mixture might depend upon the peculiar Texture of the Sal Armoniack whereby, whilst the Water is dissolving it, either some Frigorifick particles are extricated and excited, or (rather) some particles, which did before more agitate the minute parts of the water, are expell'd (or invited out by the ambient Bodies) or
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come to be clogg'd in their motion : Whence it seem'd reasonable to expect that upon the Reunion of the Saline particles into such a Body , as they had constituted before, the redintegrated Sal Armoniack having, neer upon , the same Texture, would, upon its being redissolv'd, produce the same, or a not much inferior degree of Coldness : And hereupon , though I well enough foresaw that an Armoniack solution, being boyl'd up in Earthen vessels (for Glass ones are too chargeable) would, by piercing them , both lose some of the more subtile parts, and thereby somewhat impair the texture of the rest ; yet I was not deceiv'd in Expecting, that the dry Salt, remaining in the pipkins, being redissolv'd in a due proportion of water, would very considerably infrigidate it; as may further appear by the Notes, which for your greater satisfaction you will find here subjoyn'd, as soon as I have told you, that, though for want of other vessels I was first reduc'd to make use of Earthen ones, and the rather, because some Metallin Vessels will be injur'd by the dissolv'd Sal Armoniack, if it be boyl'd in them; yet I afterwards found some conveniences in Vessels of other Metall, as of Iron; whereof you may command a further Account.

March the 29th, the Thermoscope in the Air was at $8\frac{3}{4}$ inches; being put into a somewhat large evaporating glass, fill'd with water, it fell (after it staid a pretty while, and had been agitated in the liquor) to 8. inches: then about half the Salt, or less, that had been used *twice* before, and felt much less cold than the water, being put in and stirr'd about, the tinted Spirit subsided with a visible progress, till it was saln manifestly beneath 4. inches; and then, having caused some water to be freshly pump'd and brought in; though the newly mention'd Solution were mixt with it, yet it presently made the Spirit of Wine manifestly to ascend in the Instrument, much faster, than one would have expected, &c.

And thus much may suffice for this time concerning our *Frigorifick* Experiment; which I scarce doubt but the *Cartesians* will lay hold on as very favourable to some of their Tenens; which you will easily believe, it is *not* to the Opinion, I have elsewhere oppos'd, of those Modern Philosophers, that would have *Salt. petre* to be the *Primum Frigidum*: (though I found by trial, that, whilst 'tis actually dissolving; it gives a much considerabler degree of Cold, than otherwise.) But about the Reflexions, that may be made on this Experiment, and the Variations, and Improvements, & Uses of it, though I have divers things lying by me; yet, since you have seen several of them already, and may command a sight of the rest, I shall forbear the mention of them here, not thinking it proper, to swell the bulk of this Letter with them.

An Account of two Books lately printed in London.

1. EUCLIDIS ELEMENTA GEOMETRICA, novo ordine ac methodo demonstrata. In this compendious and pretty Edition, the Anonymous Author pretends to have rendred these Elements more expeditious; by bringing all together into one place, what belongs to one and the same subject: Comprising 1. what *Euclid* hath said of *Lines*, *Streight*, *Intersecting* one another, and *Parallel*. 2. What he hath demonstrated of a *Single Triangle*, and of *Triangles Compared* one with another. 3. What of the *Circle*, and its Properties. 4. What of *Proportions* in *Triangles* and other Figures. 5. What of *Quadrats* and *Rectangles*, made of *Lines* diversly